THE WEATHER AND CIRCULATION OF SEPTEMBER 1951[1]

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The 700-mb. circulation pattern for the month of September (fig. 1) shows that North American weather was dominated by a ridge extending southward from the Yukon along and off the Pacific Coast to about 45° N. and an accompanying trough to its east reaching from Kansas to Baffin Island. Off either coast of the southern United States was a weak secondary trough. These two troughs were separated by a High centered in the northern Bahamas with a stronger than normal ridge line extending west-northwestward through the northern Gulf of Mexico, central Texas, and southern New Mexico and Arizona. Thus, troughs and ridges at high latitudes were out of phase with those at lower latitudes. As a result, the confluence of contrasting air masses [1] was a prominent feature of the September pattern, more or less as it had been all summer [2, 3, 4]. The axis of confluence in the central United States was accompanied by stronger than normal westerlies downstream across eastern North America and the Atlantic Ocean.

[1] See Charts I–XV following p. 187 for analyzed climatological data for the month.

In this fast westerly flow numerous cyclones sped eastward, deepening as they approached the central Atlantic trough (Chart X). These cyclones were both deeper and farther south than usual for September, as indicated by the large negative departures from normal of both 700-mb. height (fig. 1) and mean sea level pressure (Chart XI

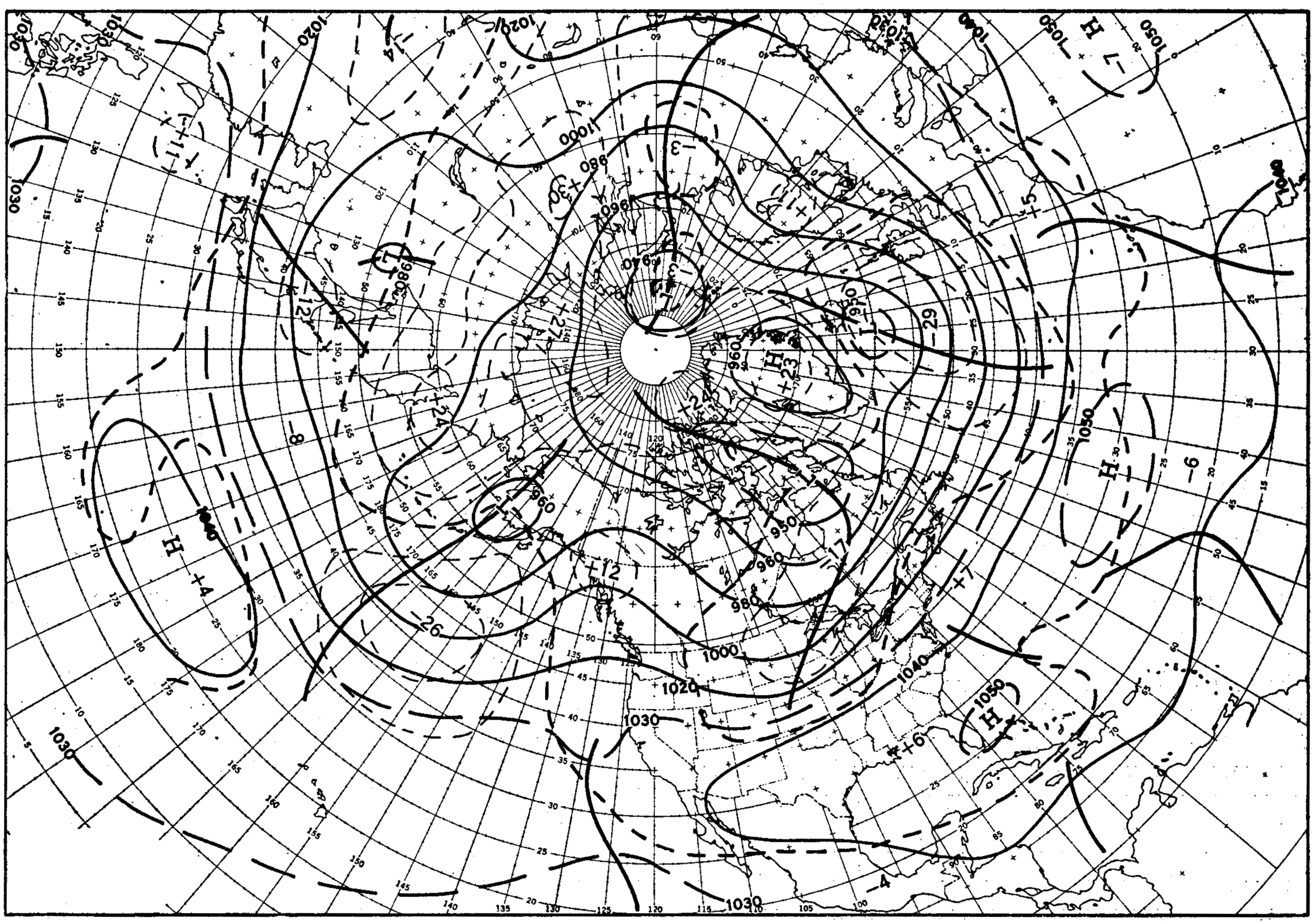


FIGURE 1.—Mean 700-mb. chart for 30-day period August 31–September 30, 1951. Contours at 200-foot intervals are shown by solid lines, intermediate contours by lines with long dashes, and 700-mb. height departures from normal at 100-foot intervals by lines with short dashes with the zero isopleth heavier. Anomaly centers and contours are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines.

inset) south of the normal storm path and centered just to the south of Iceland. This area of persistent cyclonic activity reached its climax on September 11 when a low of tropical origin (hurricane "Fox") was reported to be of 963-mb. intensity southwest of Iceland. Climatological records for the area indicate that a September storm of this depth occurs about once in 10 years.

Cyclonic activity was also well marked in the eastern Pacific trough, but only a few storms managed to break through the mean ridge along the west coast of North America. Many of the Lows stalled and filled as they approached the ridge, while not infrequently northerly and northwesterly trajectories were taken by other storms skirting its periphery (Chart X). The ridge was remarkably persistent until the last decade during which it retrograded rapidly. When, in the course of this retrogression, the ridge reached the Bering Sea, cold Arctic air poured down its eastern side into the Gulf of Alaska where rapid cyclogenesis occurred. At least two storms entered the Pacific Northwest during the latter stage of this development and effected a much needed relief after prolonged drought in this area.

Over North America there was a broad but well defined association of the daily pressure systems with the mean upper level circulation. Most of the cyclones either came over the top of the ridge in the Yukon or developed east of the Canadian Divide in southwestern District of Mackenzie and proceeded southeastward (Chart X). Almost all these storms turned eastward to northeastward as they crossed the 95th meridian. Further activity was provided by a number of secondaries which formed in the Northern Plains of the United States and moved northeastward; one of these reached a depth of 970 mb. in central Hudson Bay on the 14th. Practically all of these storms passed off the North American coast between 50° and 60° N. latitude in the region of strong cyclonic shear just north of the band of strong westerlies at 700 mb. (fig. 1). A more detailed discussion of one of these developments may be found in an adjacent article by J. A. Carr [5].

These cyclonic developments over the Northern Plains were frequently followed by cold polar outbreaks over the north central area of the United States. The accompanying major anticyclone track was from western Canada southeastward across the Northern and Central Plains and eastward through the northeastern States (Chart IX). The difference in latitude between the mean cyclone and anticyclone tracks is especially well defined in eastern North America where very little overlapping is indicated (compare Charts IX and X). Particularly conspicuous is the lack of normal cyclonic activity in the northeastern United States.

This regime produced a mean temperature anomaly pattern which seems to be becoming quite familiar. Chart I-B shows the continued dominance of below-normal temperature from the northern border of the United States, between the Continental Divide and the Appalachians, southward to Oklahoma, Arkansas, and mid-Tennessee. The remainder of the country, with very minor exceptions, was above normal in temperature with greatest departures in southern Nevada and the lower Colorado River Valley. At Yuma a new record was set when the mean September temperature equalled 90.6° F. Texas still averaged above normal but in the eastern sections of the State the mean temperature anomaly was smaller than in previous months. The greatest negative departures were observed in southeastern Montana where temperatures averaged close to 6° F. below normal.

Precipitation exceeded the seasonal normal (Chart III) in a wide band extending from northern Washington and Idaho through most of the northern Rocky Mountain States, Central Plains, lower Mississippi Valley, and the Southeast. The driest area was New Mexico where the State precipitation average was only 15 percent of normal and soils were reported too dry for the planting of winter grain. The Middle Atlantic States and most of New England also reported below-normal rainfall. Virginia had the driest September in 10 years and in some localities it was considered the worst drought in 20 years.

Two areas finally experienced relief from prolonged abnormalities which had caused considerable damage and concern. First, the drought and fire hazard in the Pacific Northwest was ended (as previously described) just as plans for the moving of industrial plants dependent upon hydroelectric power were being seriously considered. Second, the unusually persistent heat wave and drought in Texas [2] continued unbroken in September until about the middle of the month when a cold front passage followed by a prolonged spell of northeasterly circulation (and a second cold outbreak) gave much needed cooling and precipitation. A 24-hour total of 13.77 inches of rain was recorded at Alice, Tex., on September 14 and resulted in considerable property damage due to flash floods. Prior to this break, daily maximum temperatures of 110° F. at Presidio and 105° F. at Del Rio, Tex., had set new September records.

The continued cool weather and fairly general precipitation over the North Central States were again accompanied by below-normal sunshine (Chart VII-B). The result of this regime was the slow maturation of crops, particularly the Iowa corn crop. A hard freeze on the 28th (21° F. recorded at Inwood) caused widespread damage except for local areas in the eastern and southeastern portions of the State. One-third of the crop was estimated to be vulnerable, and losses were proportional to the severity of the local freeze. It was ironical that the cold spell was of very short duration, and temperatures soared to a State high of 91° F. by October 1.

Just as ironical, but in a much more felicitous vein, was the diversion which spared Bermuda serious hurricane damage. Figure 2 shows the tracks of Atlantic hurricanes "Easy" and "Fox" as related to the 5-day mean 700-mb. pattern. "Easy" was turning northward from the 7th to the 8th as a polar trough moved off the east coast of the

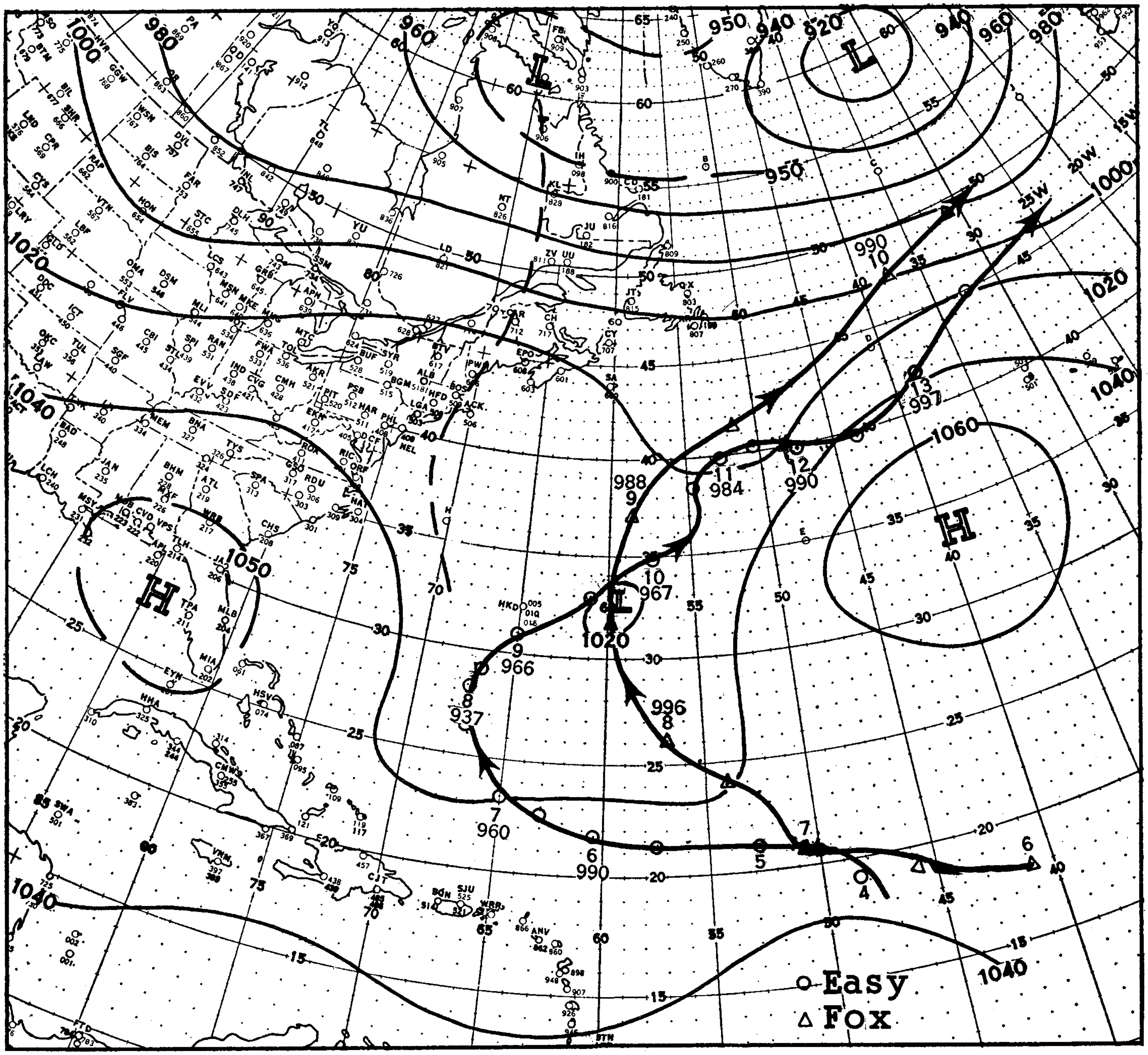


FIGURE 2.—Tracks of hurricanes "Easy" and "Fox" superimposed on 5-day mean 700-mb. contours for period September 8–12, 1951. Date and approximate intensity (in millibars) at storm center are given for 1230 GMT positions, with 0030 GMT positions also indicated by circles for "Easy" and triangles for "Fox". Dashed line along 70th meridian indicates position of mean trough one-half week previously. Contours are labeled in tens of feet.

United States. Hurricane "Fox" was not far behind and traveling northwestward somewhat faster than "Easy" as it was still steered by the warm anticyclone to its north-northeast. With the approach of the polar trough it too began to recurve, however, at a faster rate and farther east than "Easy." On the morning of the 9th, "Fox" was still the weaker of the two storms and centered east-northeast of Bermuda, while "Easy" was somewhat the stronger and almost south of Bermuda. The interactions of the two circulations weakened the circulation around "Easy" and accelerated its eastward component of motion. The storm passed within a hundred miles of Bermuda but instead of the commonly anticipated hurricane speeds only moderately high winds were observed. Presumably the weakening of "Easy" from the 8th to the 9th and its eastward acceleration due to the intervention of "Fox" were all that prevented serious damage to Bermuda. More intensive studies of this situation will undoubtedly be forthcoming.[2] In all, it should be accounted one of those fortuitous interactions which are certainly not uncommon but which seldom appear to be so timely and spectacular.

Mention has already been made of the familiar aspect of

[2] A brief discussion of these and other recent hurricanes appears in *Weatherwise*, vol. 4, No. 5, October 1951, pp. 105–106.

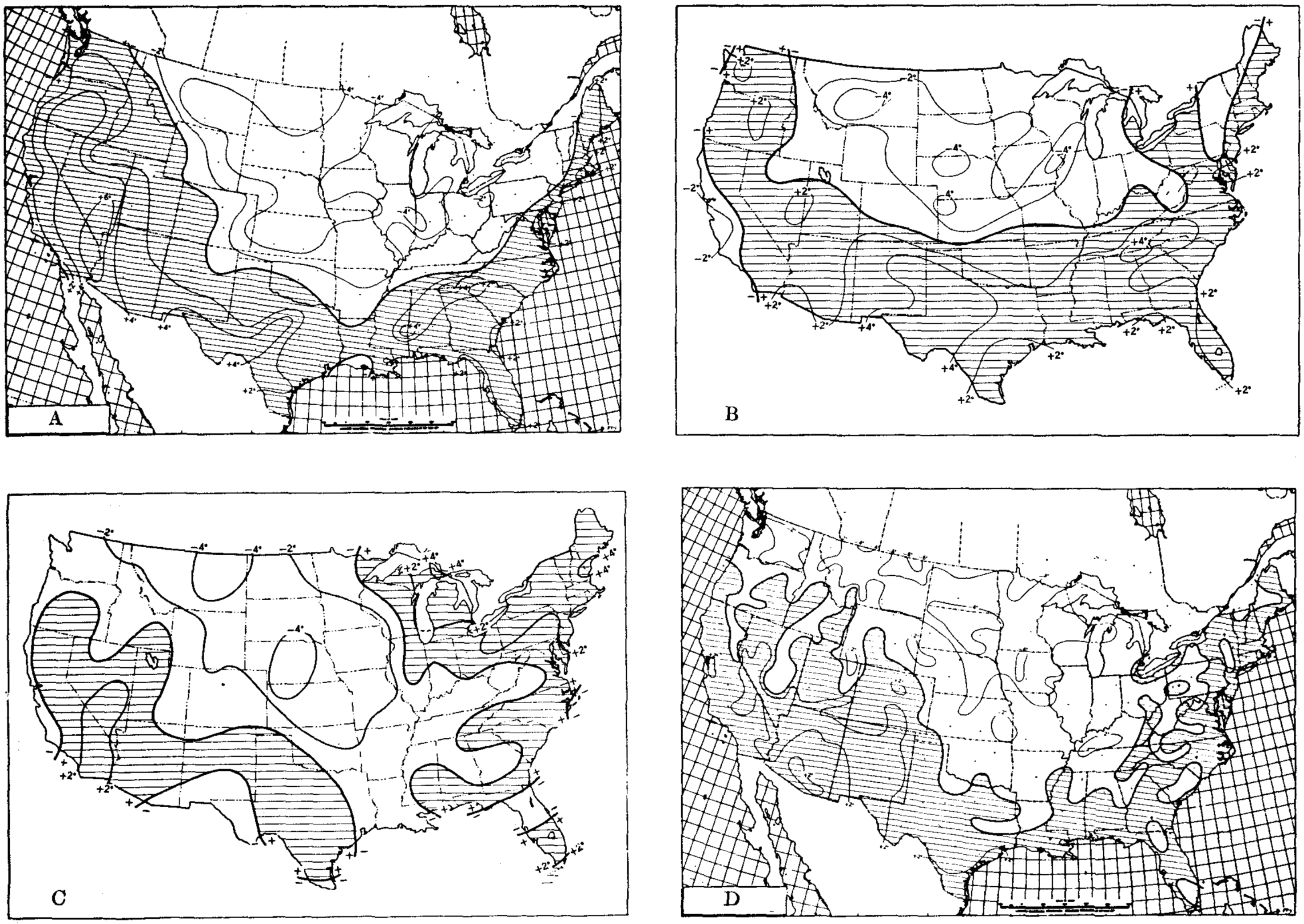


FIGURE 3.—Temperature anomalies in the United States, (a) September 1951, (b) summer 1951 (June, July, August), (c) spring 1951 (March, April, May), and (d) year 1950. Not over-all persistence of below-normal temperatures in North Central United States with above-normal anomalies in peripheral areas. (Parts b and c from U. S. Weather Bureau *Weekly Weather and Crop Bulletin*, June 12, 1951, and September 18, 1951; part d from U. S. Weather Bureau, *Climatological Data, National Summary*, Annual 1950.)

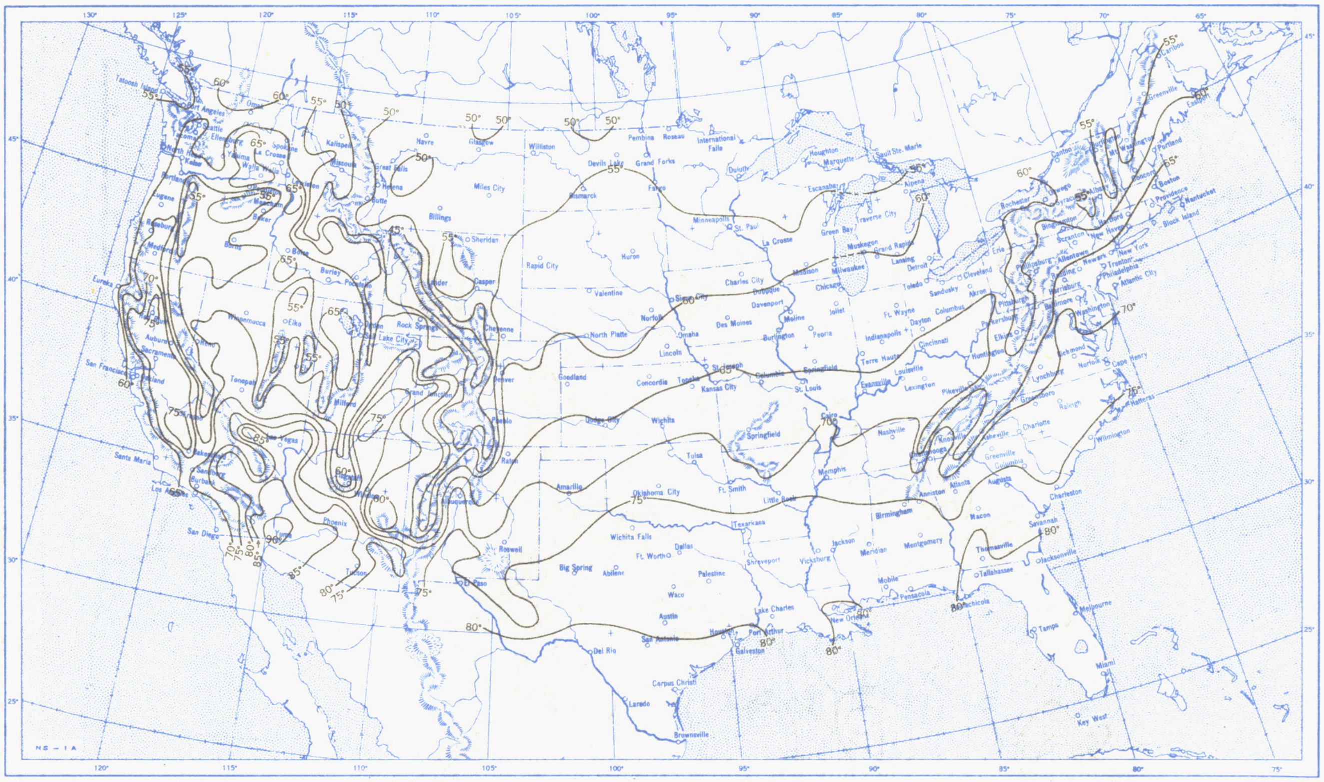
this month's temperature pattern. Figure 3, however, conveys better than words just how persistent this over-all regime has become. A comparison of 3A with 3B shows clearly that the September temperature departures resembled strikingly the mean departures for the summer of 1951 (June, July, August). The upper level mean circulation patterns during this period were dominated by a ridge in the eastern Gulf of Alaska or western Canada which caused frequent cold air intrusions in the North Central United States. Fluctuations in the position and intensity of the trough downstream and the Bermuda High (particularly the westward ridge extension) allowed considerably wider variations in the precipitation pattern (not shown), but many features of the September precipitation pattern also resemble the pattern observed during the summer.

Furthermore, the spring of 1951 had a similar temperature pattern (fig. 3C). The basic mean circulation pattern of spring likewise contained much the same dominant features over North America. Still more amazing is the similarity of the over-all temperature anomaly for the entire year 1950 shown in figure 3D. Such long period persistence, or rather, persistent recurrence of similar climatic anomalies, poses to the meteorologist a problem of vast economic importance whose solution, for the present at least, appears remote.

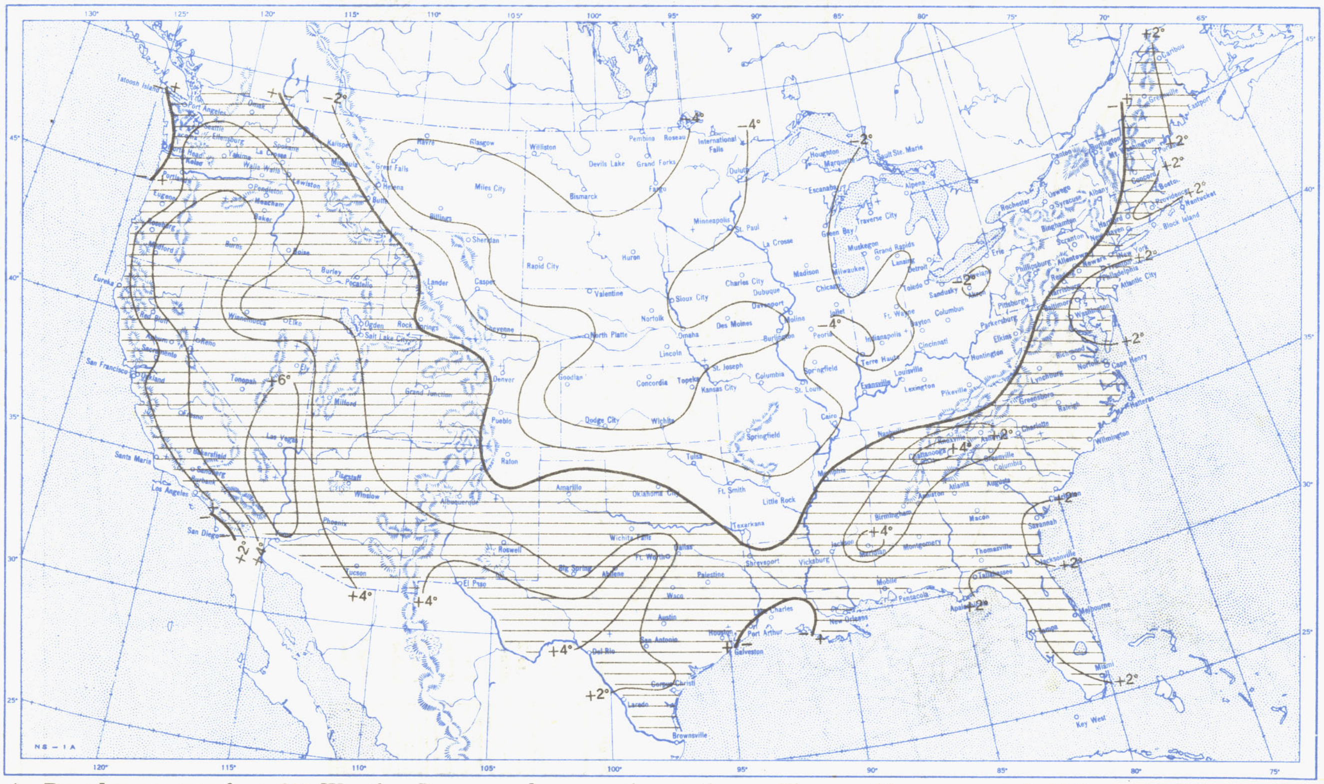
REFERENCES

1. J. Namias and P. F. Clapp, "Confluence Theory of the High Tropospheric Jet Stream," *Journal of Meteorology*, vol. 6, No. 5, October 1949, pp. 330–336.
2. V. J. Oliver, "The Weather and Circulation of August 1951," *Monthly Weather Review*, vol. 79, No. 8, August 1951, pp. 160–162.
3. V. J. Oliver, "The Weather and Circulation of July 1951," *Monthly Weather Review*, vol. 79, No. 7, July 1951, pp. 143–146.
4. L. H. Clem, "The Weather and Circulation of June 1951," *Monthly Weather Review*, vol. 79, No. 6, June 1951, pp. 125–128.
5. J. A. Carr, "Movement of the Storm of September 25–30, 1951", *Monthly Weather Review*, vol. 79, No. 9, September 1951, pp. 183–187.

Chart I. A. Average Temperature (°F.) at Surface, September 1951.

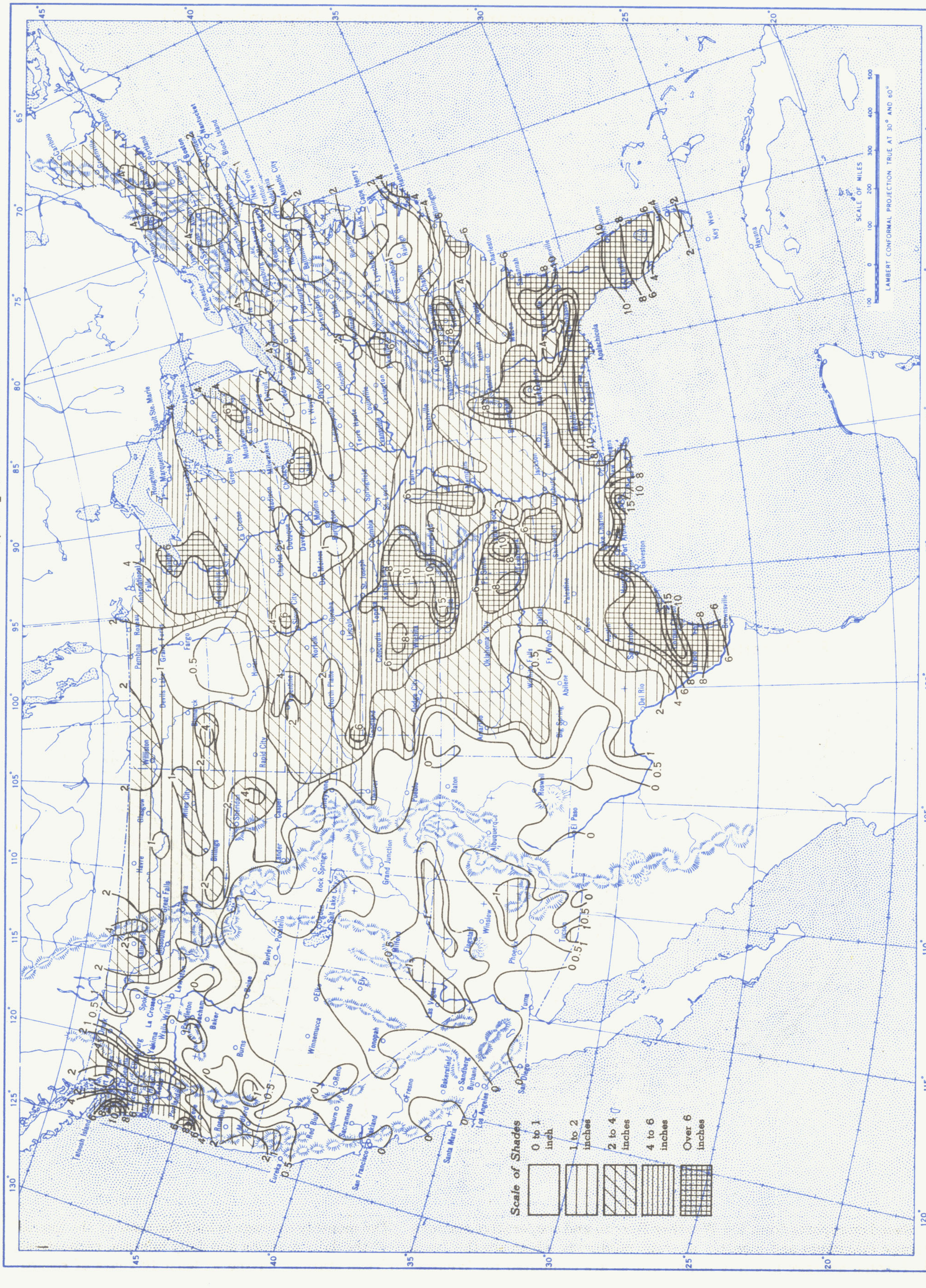


B. Departure of Average Temperature from Normal (°F.), September 1951.



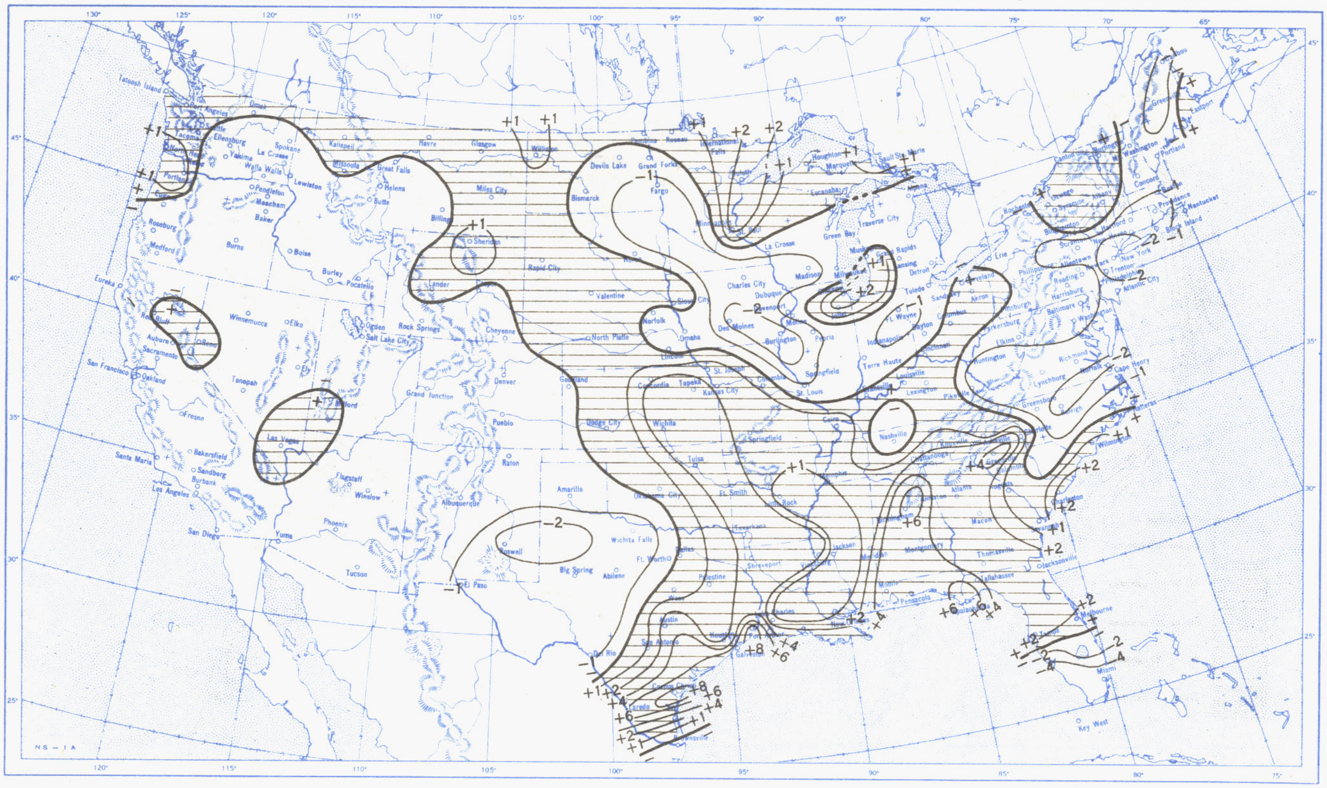
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), September 1951.

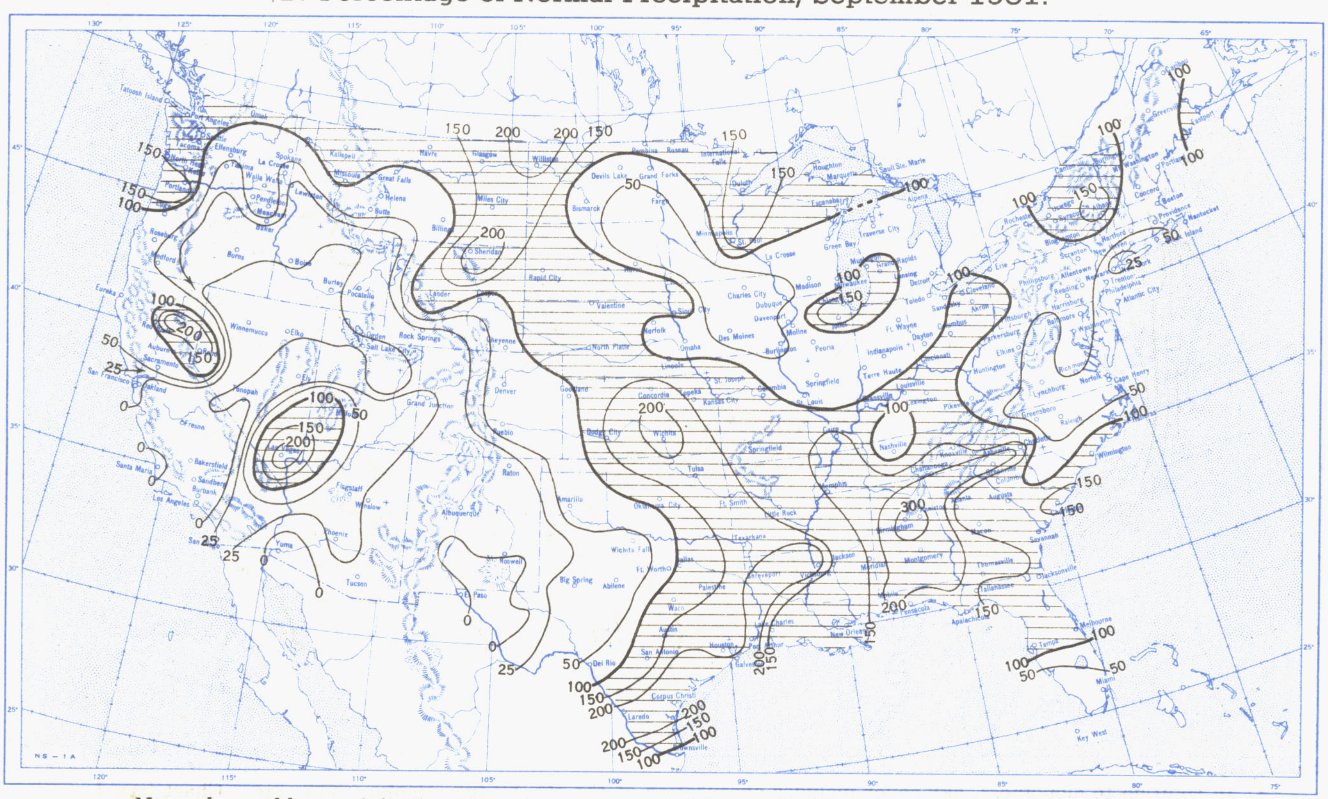


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), September 1951.

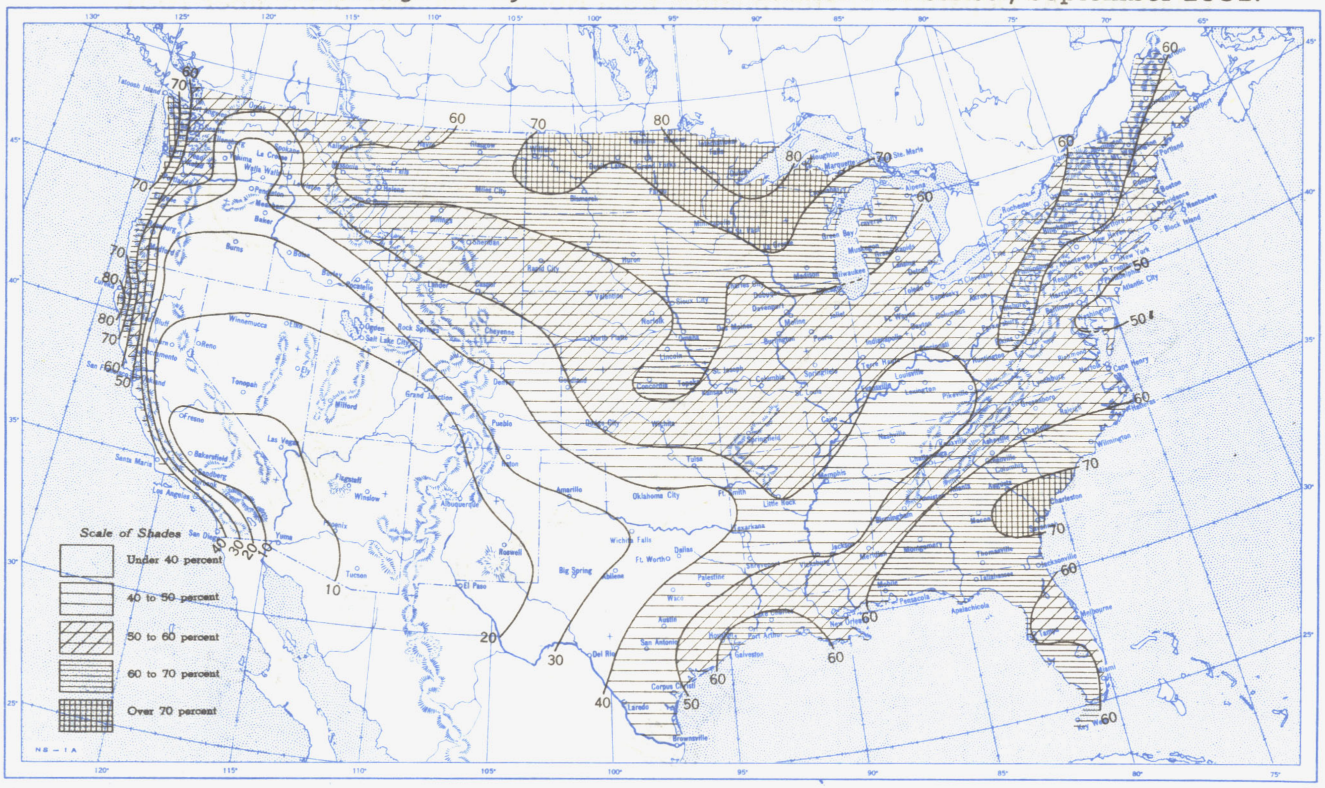


B. Percentage of Normal Precipitation, September 1951.

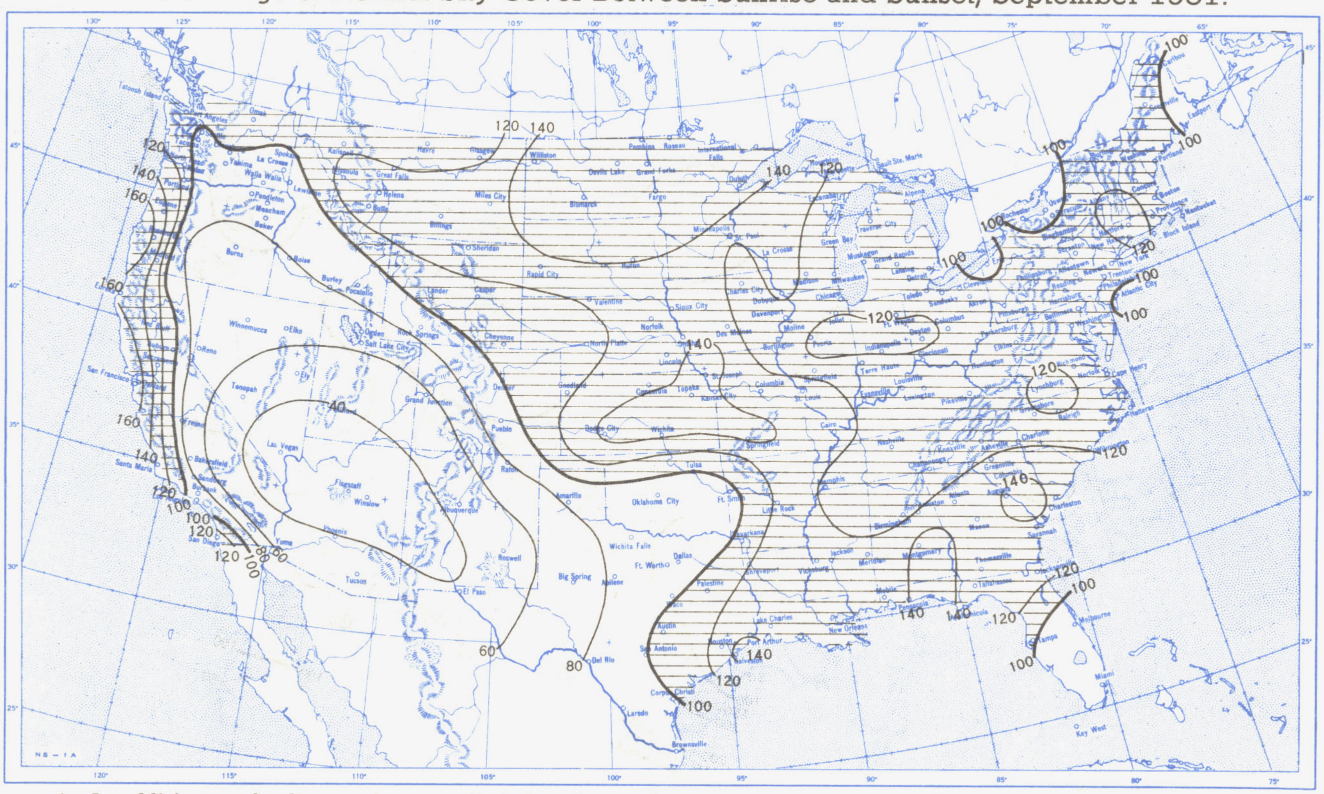


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, September 1951.

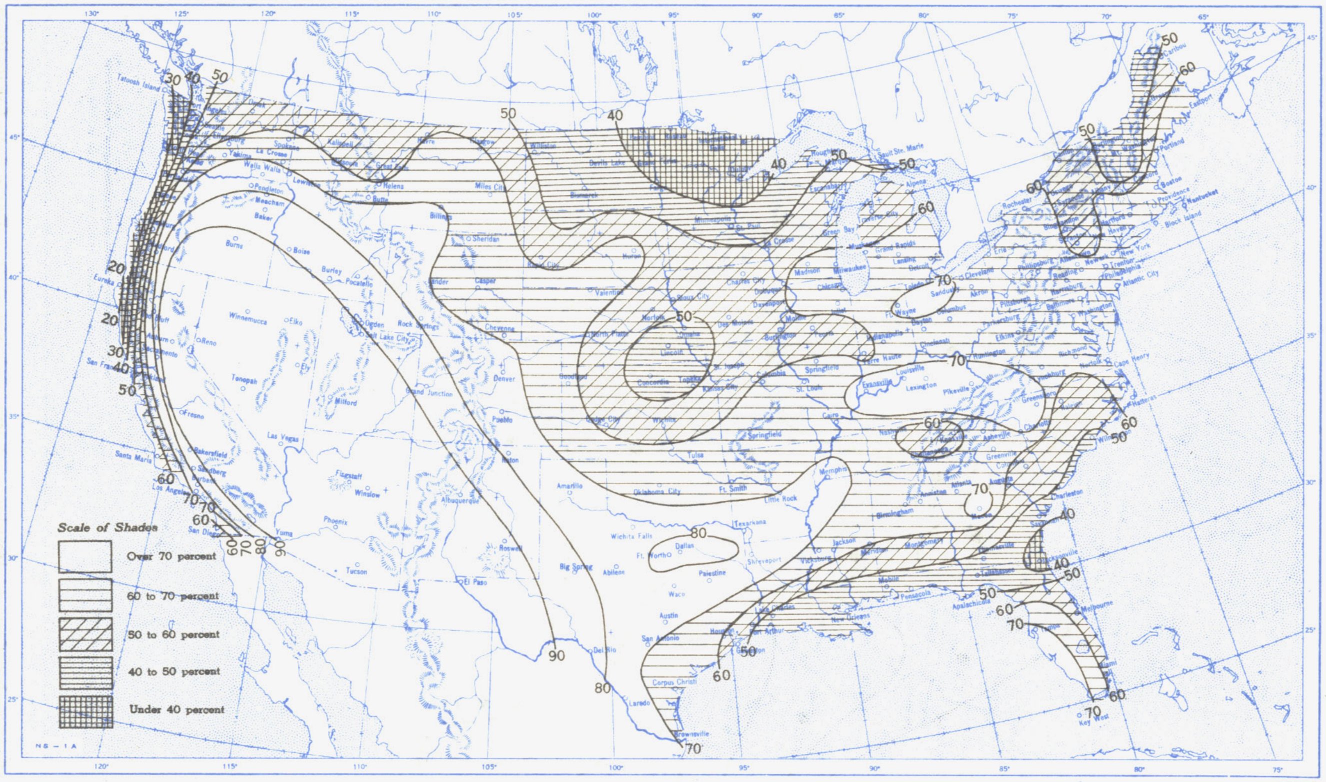


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, September 1951.

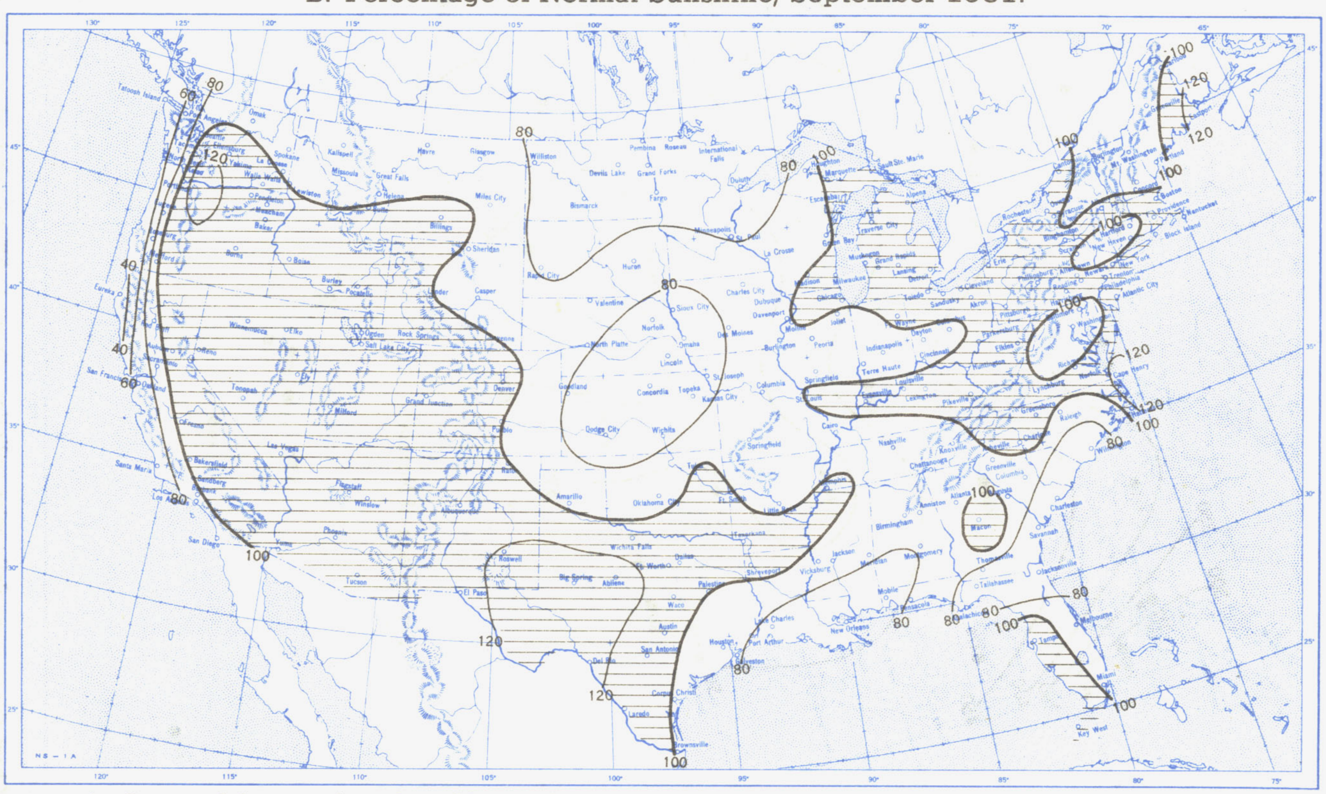


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, September 1951.



B. Percentage of Normal Sunshine, September 1951.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, September 1951. Inset: Percentage of Normal Average Daily Solar Radiation, September 1951.

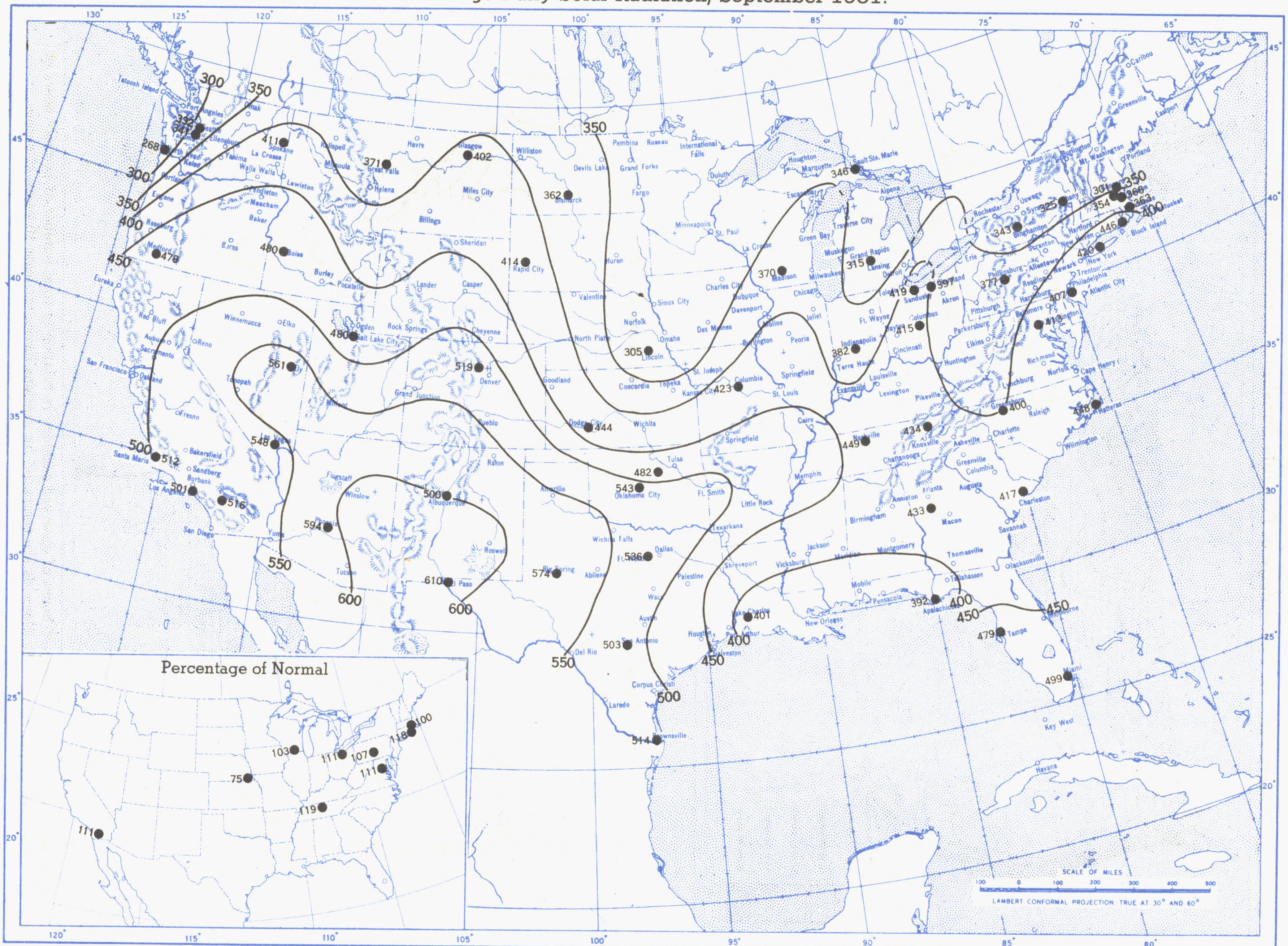
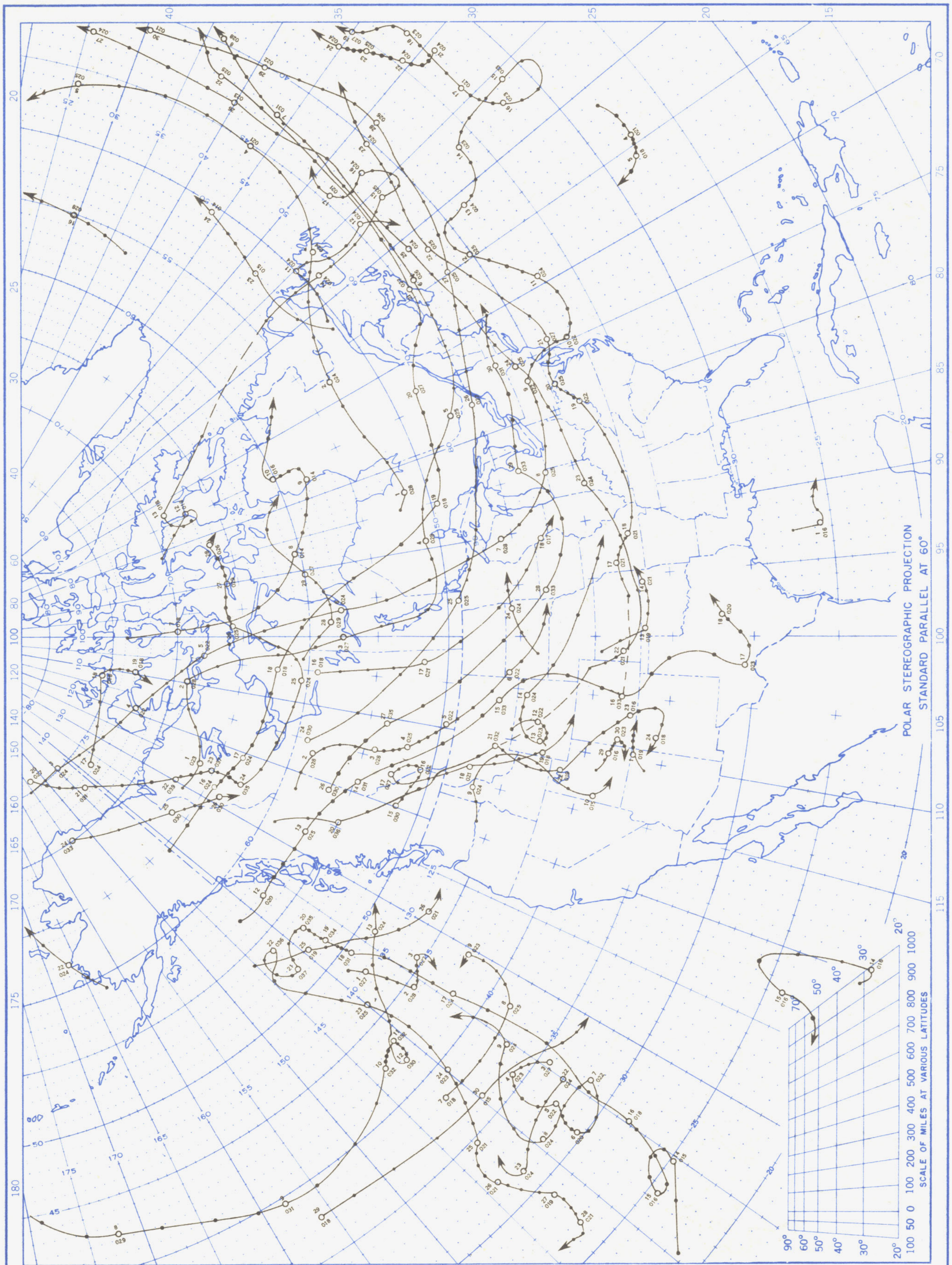


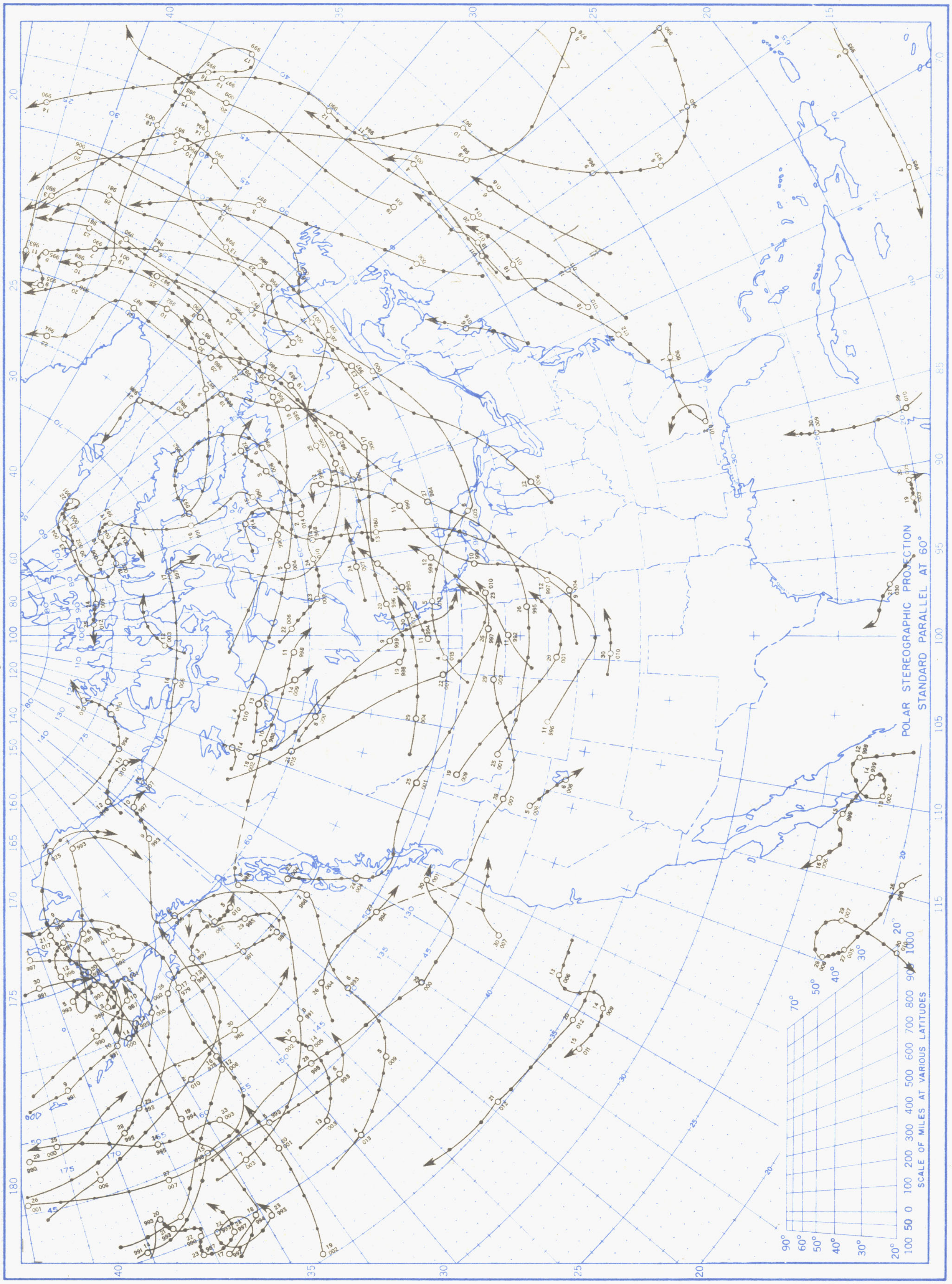
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. $^{-2}$). Basic data for isolines are shown on chart. Further estimates obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, September 1951



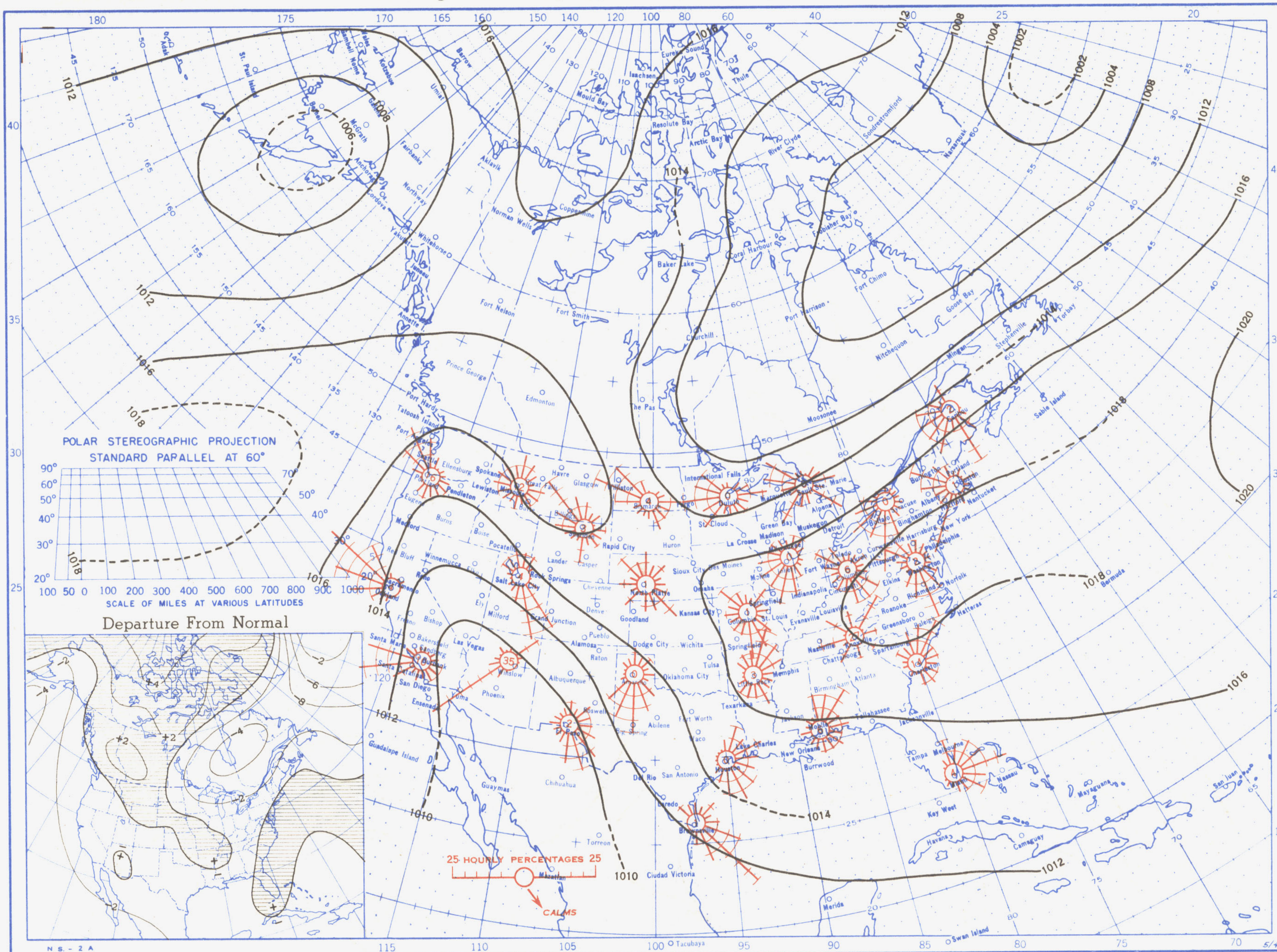
Circle indicates position of center at 7:30 a.m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, September 1951.



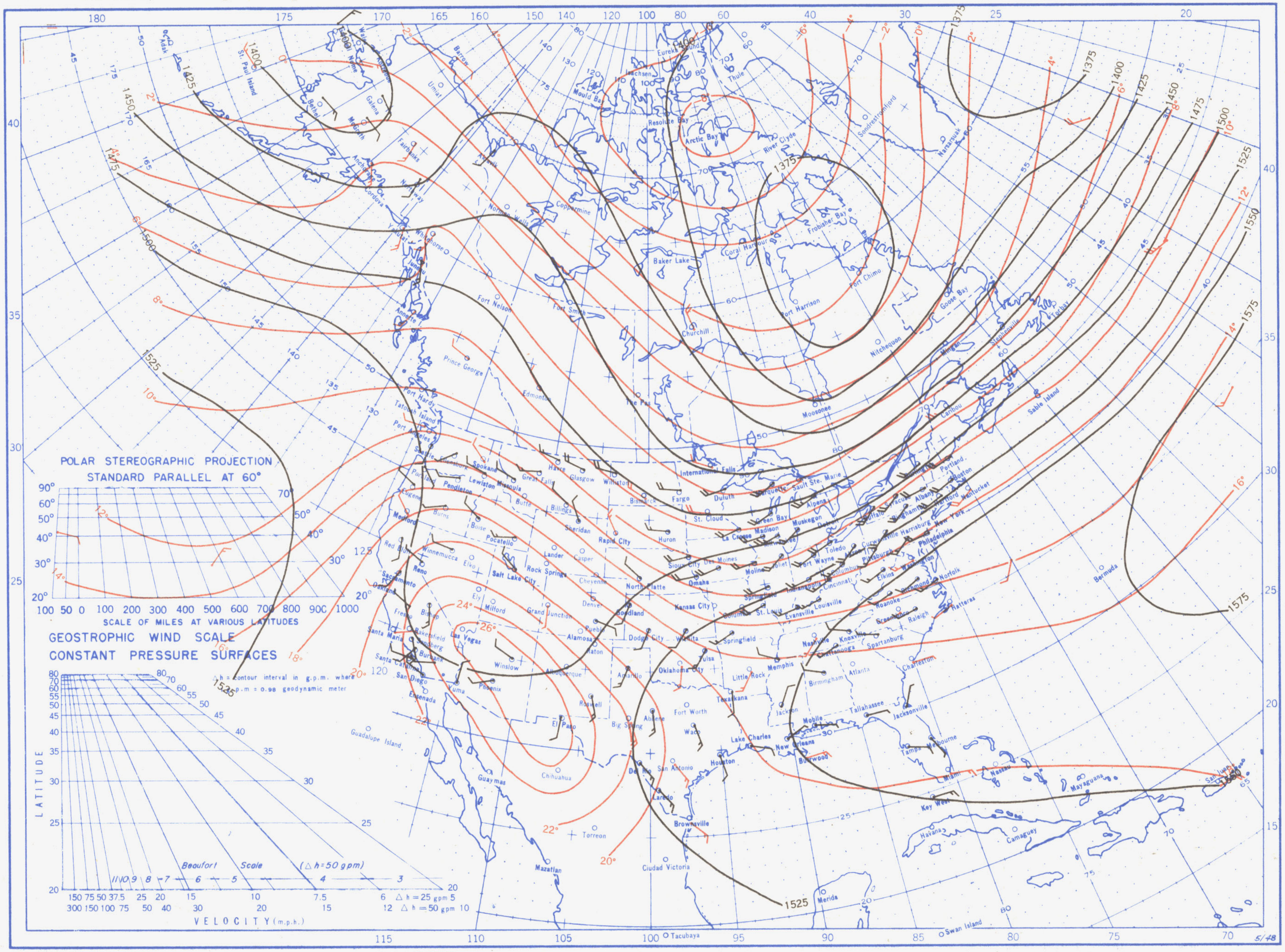
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, September 1951. Inset: Departure of Average Pressure (mb.) from Normal, September 1951.



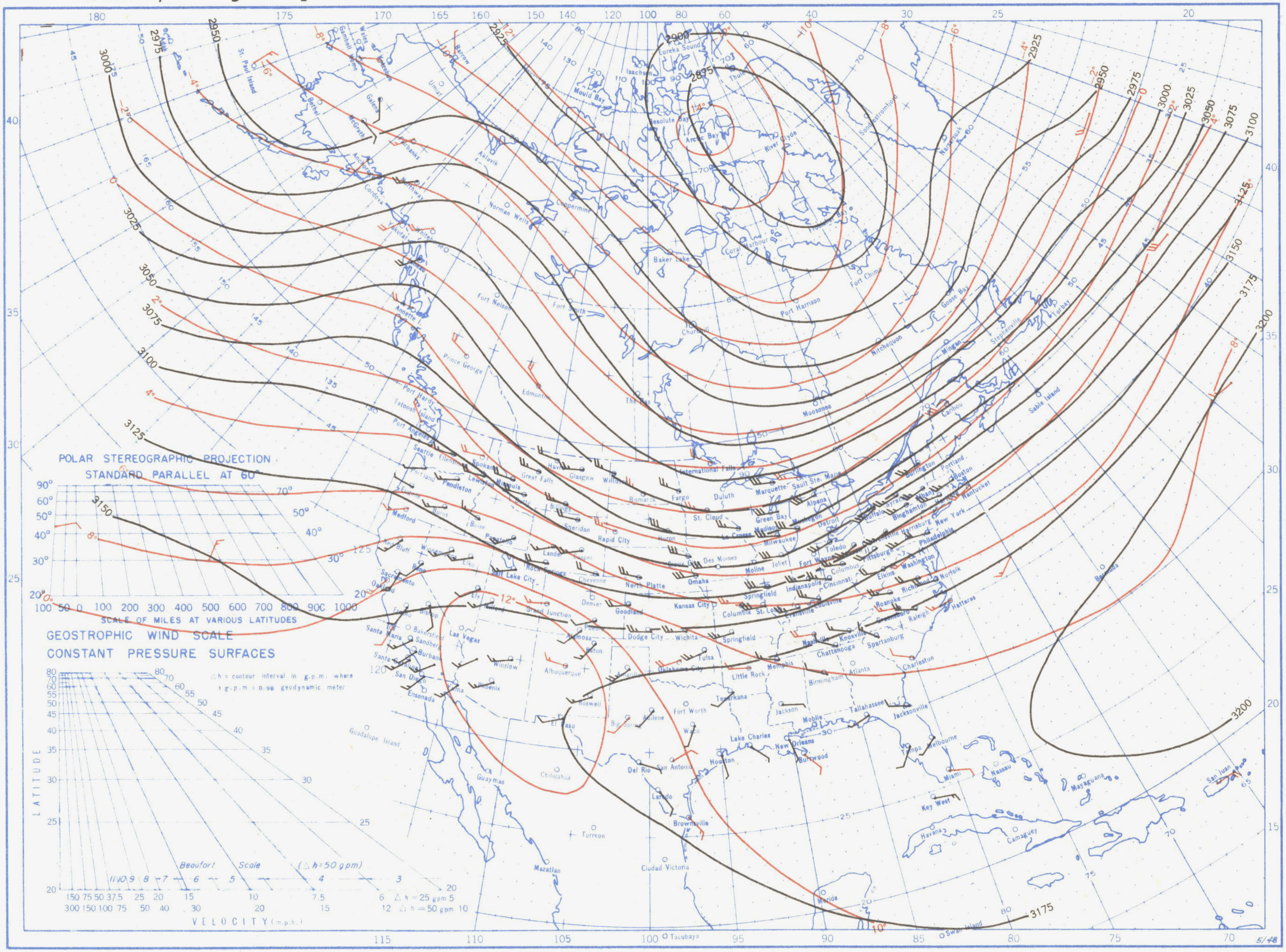
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid from map readings for 20 years of the Historical Weather Maps, 1899–1939.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), September 1951.



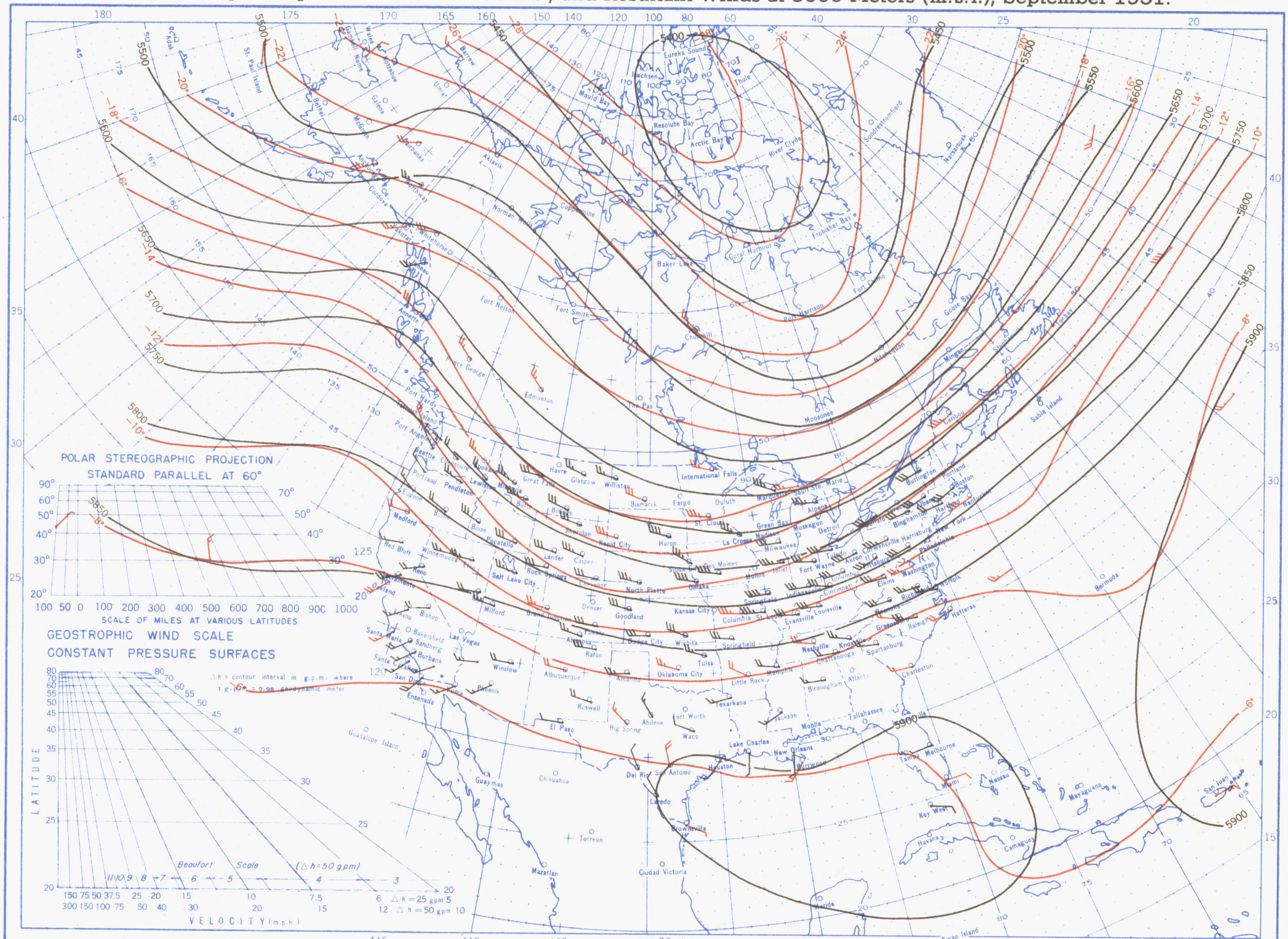
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m.. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), September 1951.



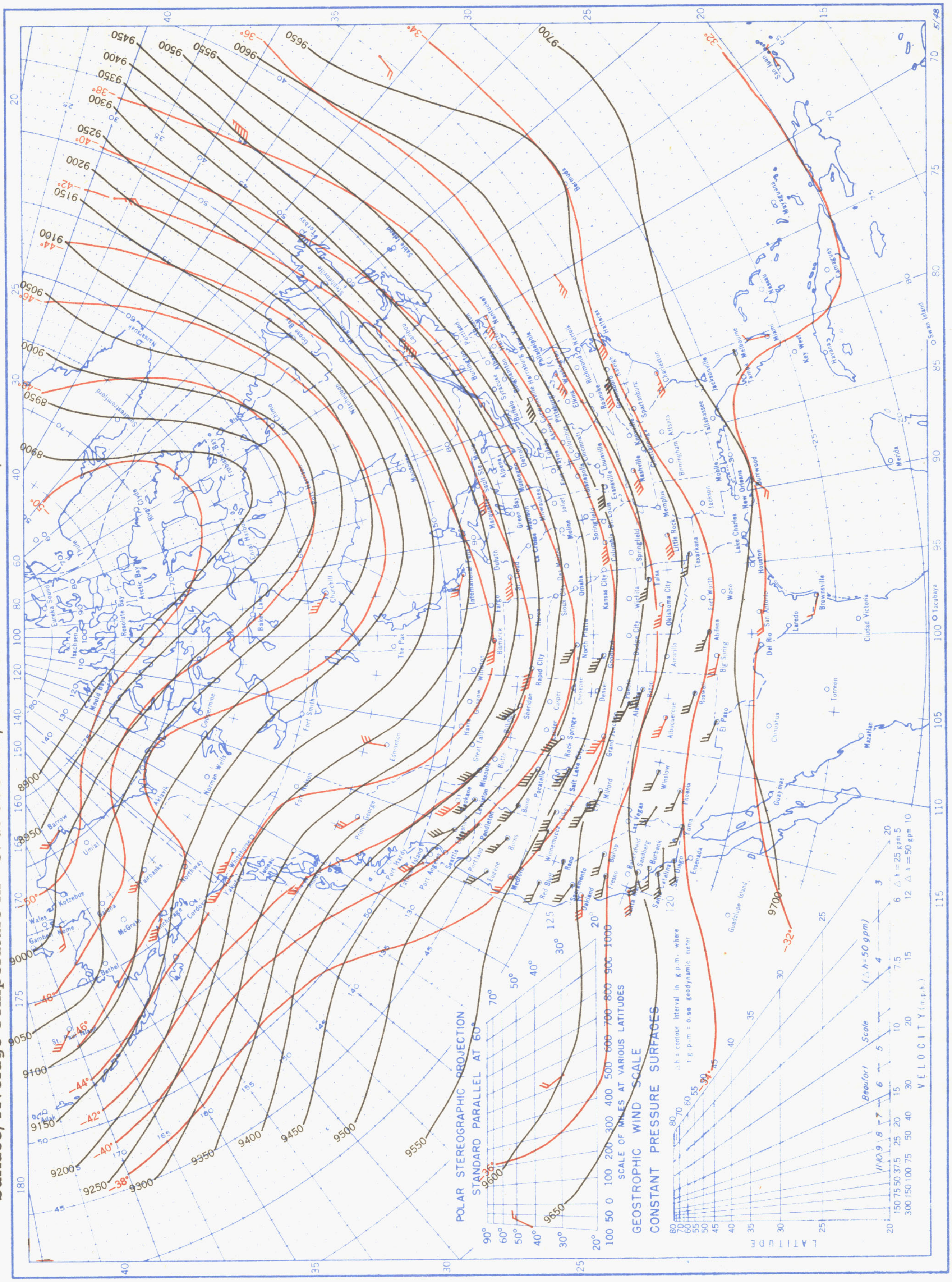
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), September 1951.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), September 1951.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.